

### REMARKS

In response to the Office Action mailed August 26, 2003, Applicants request reconsideration. No claims are proposed to be added, cancelled, or even amended so that claims 1-16 remain pending. Claim 1 is the sole pending independent claim. Although there is a rejection as to form with respect to all claims, based upon claim 1, if claim 1 is patentable, then so are claims 2-15. Thus, the following discussion focuses on claim 1.

#### Rejection Pursuant to 35 USC 112

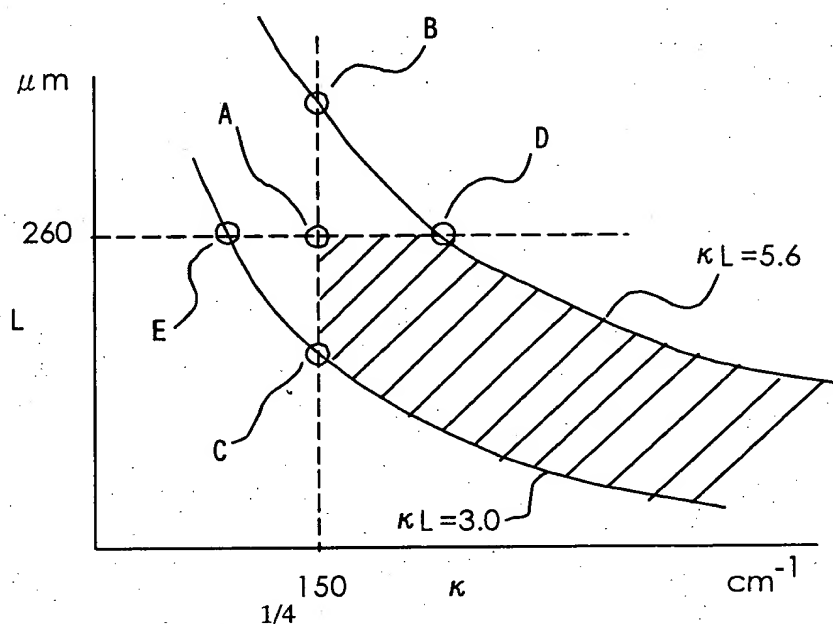
All claims were rejected pursuant to 35 USC 112, second paragraph as indefinite. The Examiner took the view that claim 1 expresses both a broad range and an embedded narrower range, leading to confusion as to the limits of the claim. Further, the Examiner made calculations and asserted that the two allegedly disclosed ranges are not consistent with each other. Both grounds of rejection are erroneous.

Turning first to the Examiner's calculations, it appears that some errors have been made with respect to units. The variable of interest with regard to this rejection is  $\kappa L$ . Claim 1 specifies that  $\kappa$ , the coupling factor, is at least  $150 \text{ cm}^{-1}$ . Thus, in this part of claim 1, a lower limit, but not an upper limit, is specified for  $\kappa$ . Claim 1 also specifies that  $L$ , the length of the diffraction grating, does not exceed  $260 \mu\text{m}$ . Again, only one end of a range of  $L$  is specified in this part of claim 1. It is important to realize that the product,  $\kappa L$ , is unitless and that the units of  $\kappa$  and  $L$  specified in the claim are different. Therefore, when the two values are multiplied, the units must be rationalized so that the product is truly a unitless number. Perhaps there might have been less potential for confusion if the coupling factor  $\kappa$  were expressed as at least  $150 \mu\text{m}^{-4}$ , rather than the units that appear in claim 1, but the units that are used in claim 1 for the coupling factor are the conventional units used in the art. Finally, claim 1 specifies that the product  $\kappa L$  is less than 5.6 and more than 3.0, thereby providing additional limits on the ranges of  $\kappa$ ,  $L$ , and  $\kappa L$ .

Turning first to the mathematical calculation of the Office Action, the Examiner stated that if  $L$  is  $260 \mu\text{m}$  and  $\kappa$  is at least  $150 \text{ cm}^{-1}$ , then the product of these two numbers falls outside the inequality that appears in claim 1. In fact, the product of these two numbers is 3.9, a number that falls within the range specified in claim 1. The product of 260 and 150 is  $39000 \mu\text{m} \cdot \text{cm}^{-1}$ . To eliminate the units, that product must be multiplied by a factor of  $10^{-4}$  so that the unitless product of these two factors is 3.9, well within the specified range. Further, when  $\kappa = 150 \text{ cm}^{-1}$ , in order for the product  $\kappa L$  to be less than 5.6,  $L$  must be less than  $373 \mu\text{m}$ , not 3.73m. There has been confusion in the units by a factor of 10,000. Applicants agree that the latter example falls outside the scope of the invention. However, determining whether a set of variables falls within

or outside the invention, i.e., the scope of the claims, does not establish whether the claims are definite or indefinite. The essential point to be understood with respect to this first response to the rejection as to form is that the mathematical analysis of the Office Action is incorrect.

The scope of claim 1 is best understood graphically. As known to those of skill in the art, the product  $\kappa L$  for a semiconductor laser can be plotted on a graph in which the ordinate represents the length  $L$  of the diffraction grating of the semiconductor laser and the coupling constant  $\kappa$  can be plotted on the abscissa. These variables are interrelated with the result, as known in the art, that a graph of these two variables and their relationship results in a curve for a constant value of the product  $\kappa L$  that is a curve, asymptotic to both the ordinate and abscissa. An example of such a graph, illustrating the scope of the mathematical portion of claim 1 follows.



The graph illustrates two lines for respective constant products of  $\kappa L$ , one for 5.6 and one for 3.0, the two values in the inequality appearing at the end of claim 1. Claim 1 thus specifies that the product of  $\kappa L$  must fall between these two lines. Further, claim 1 specifies that the coupling constant must be greater than  $150\text{cm}^{-1}$ . This condition is shown in the graph by the vertical broken line. That line intersects the two curves at points b and c, meaning that the scope of the claim only extends to the area between the two curves and to the right of vertical line in the graph. Further, claim 1 specifies that the length of the diffraction grating does not exceed  $260\mu\text{m}$ , represented by the horizontal line in the graph that intersects the two curves at points d and e. This line produces yet a second limitation on the area between the

two curves. Based upon these two limitations established by the vertical and horizontal lines, claim 1 states that the product  $\kappa L$  for the semiconductor lasers falling within the scope of the claim are in the area of the figure that has diagonal hatching lines. This graph shows conclusively that claim 1 does not include, as asserted by the Examiner, a narrower range embedded within a wider range. Rather, the range specified in the claim and determined by each of the three mathematical limitations that are part of the claim clearly, defines a specified region, as exemplified by the figure. Thus, claim 1 cannot be indefinite.

For these reasons, the rejection of claims 1-16 as indefinite, based upon the mathematical parameters expressed in claim 1 is erroneous and, upon reconsideration, should be withdrawn.

### **The Prior Art Rejection**

At page 3 of the Office Action, the same three references referred to in the rejection of the previous Office Action are listed. However, there are no comments in the Office Action mailed August 26, 2003 concerning the patent to Suzuki. Thus, it is considered that the citation of Suzuki at the next-to-last line of page 3 of the Official Action is an inadvertent error and that the rejection based upon Suzuki has been withdrawn. Based upon the comment of the Office Action at pages 4 and 5, it is understood that the claims are all rejected as obvious over Takahashi (U.S. Patent 5,960,023) in view of Nakajima et al. (U.S. Patent 5,412,496, hereinafter Nakajima). If the rejection has been misunderstood, then a new Office Action, even if still a final rejection, should be issued, based upon this response. The rejection as understood, i.e., Takahashi in view of Nakajima, is respectfully traversed.

The description of the semiconductor laser disclosed by Takahashi that appears in the Official Action beginning in the final line of page 3 and continuing through page 4, line 11 is not questioned. Like the semiconductor laser according to the invention, the laser described by Takahashi includes a diffraction grating having a phase-shifted structure. That semiconductor laser does not include a multiple quantum well structure as the active layer nor any of the quantitative limitations that appear in claim 1.

Applicants agree that Nakajima describes a semiconductor laser that includes an active layer with a multiple quantum well structure and having a product  $\kappa L$  of approximately 4. Referring to the graph above, if a line were drawn on the graph representing the product  $\kappa L=4$ , that line would fall between the two curve lines indicated in that graph. However, as shown by the hatched area of that graph, the requirement that  $\kappa L$  is approximately equal to 4 does not establish that the laser of Takahashi, if modifiable by the cited parts of Nakajima, would fall within the scope of claim 1. Thus, the conclusion drawn by the Examiner does not establish *prima facie* obviousness as to any claim because it does not establish that the

hypothetical semiconductor laser constructed from the two patents would meet the limitations of any pending claim.

In order to support the argument that the hypothetical combination would fall within the scope of claim 1, the Examiner relied upon the assertion that the invention merely involves the selection of desired properties of the hypothetical laser produced by modifying Takahashi with Nakajima. Applicants respectfully disagree.

Since it is not apparent whether Takahashi as proposed to be modified by Nakajima would fall within the scope of claim 1, one must probe further into the disclosures of Takahashi and Nakajima to determine whether *prima facie* obviousness can be properly asserted based upon the hypothetical relied upon in the rejection. The only quantitative information in the two patents, and not already mentioned is that Takahashi describes laser chips that are square and have an edge length of  $250\mu\text{m}$  and a  $\kappa\text{L}$  product of  $35\text{cm}^{-1}$ . It is apparent that the length of the diffraction grating in these laser chips must be less than  $260\mu\text{m}$ , and thereby within one of the quantitative limitations of claim 1. However, the product  $\kappa\text{L}$  of these lasers is so far outside the scope of claim 1 that one of skill in the art would find no teaching in Takahashi, even as modified with Nakajima's  $\kappa\text{L}$  product of approximately 4, that would direct one toward the claimed invention. The foregoing graph clearly validates this conclusion and demonstrates that *prima facie* obviousness of claim 1 cannot be properly asserted based upon the limited quantitative data disclosed in Takahashi and Nakajima.

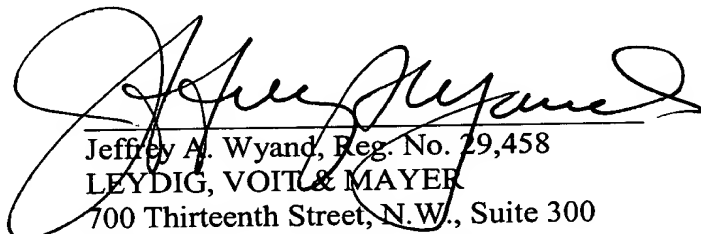
The references can be evaluated from a different perspective, relying upon the disclosure of the present patent application. As described in this application, the objective of the invention is to provide a semiconductor laser operating with a high efficiency, i.e., a low threshold current density, capable of operating at a high speed with a stable single axial mode characteristic. The invention as defined by the claims achieves all of those objectives. By contrast, neither Takahashi nor Nakajima describe any means of achieving a high relaxation oscillation frequency of a laser, an essential characteristic to achieve high frequency operation. The necessity of such a characteristic is demonstrated in a publication, published since the filing of the present patent application, in which the first named author is the first named inventor of the present patent application. A copy of that publication is attached. This paper demonstrates, based upon additional research, that the relaxation oscillation frequency of a semiconductor laser including a diffraction grating with a quarter wavelength phase shift is not solely determined by the product  $\kappa\text{L}$ . For example, Figure 1 in this paper shows that for a constant coupling factor, the relaxation oscillation frequency has a minimum value that is a function of the length of the cavity, i.e., diffraction grating. Further, the same reported measured data of Figure 1 shows that the relaxation oscillation frequency increases, as

desired, as the length of the cavity L decreases, considering the minimum relaxation oscillation frequencies for each of the examples shown in that figure. This information was not publicly known prior to the publication of the attached paper. It is on the basis on this previously unpublished knowledge that the quantitative limitations expressed in the claims have been determined. Therefore, the quantitative relationships in the claims are not the result of a mere optimization or experimentation, but the result of careful analysis and study of the behavior of semiconductor lasers with multiple quantum well active layers and phase-shifted diffraction gratings. The stated basis of the rejection is erroneous, and therefore the rejection should be withdrawn.

Finally, at page 4 of the Office Action in lines 17-21, the Examiner relied upon *In re Aller*, 105 USPQ 233, 235 (CCPA 1955) as supporting his assertion that the invention is a mere optimization. In making this assertion, the Examiner stated that "since Takahashi teaches each and every structural element of the present invention," the holding of *In re Aller* applies to show that the claims are not patentable. This position is factually wrong as demonstrated by the Office Action itself. No claim is rejected as anticipated by Takahashi, even excluding the quantitative limitations of claim 1. Rather, the basis of the rejection is the asserted modification of Takahashi with Nakajima. In other words, Takahashi does not teach each and every structural element of the claimed invention. If there were such a teaching there would have been no need to cite or rely on Nakajima. Therefore, the premise of this ground of rejection is clearly erroneous and the rejection should be withdrawn.

Reconsideration and allowance of claims 1-16 is proper and earnestly solicited.

Respectfully submitted,



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Amendment or ROA - Final (Rev. 9/3/03)